SURVEY AND ASSESSMENT OF ELECTRIC AND MAGNETIC FIELD (EMF) PUBLIC EXPOSURE IN THE TRANSPORTATION ENVIRONMENT

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1.0 EXECUTIVE SUMMARY

This research was conducted under support of the Federal Electric and Magnetic Field Research and Public Information Dissemination (EMF RAPID) Engineering Research Program. The goal was to characterize the electric and magnetic fields that a person might encounter while using various forms of transportation. It builds upon extensive past work to characterize the electric and magnetic field environment within electrified guided ground transportation systems such as electrified intracity trains, urban mass transit systems, and magnetically levitated trains [1], using standardized test protocols developed by Electric Research and Management, Inc. This effort focused on popular modes of transit such as personal cars and trucks, mass transit buses, commercial jetliners, ferry boats and electric-powered people movers, such as those which a traveler might use in an airport. The field environment of electric vehicles of the latest design was also closely examined. Electric-powered, self-contained commuter rail vehicles using variable frequency alternating current (ac) drive were also characterized to round out the previous work on electrified rail systems.

The measurement and data analysis procedures employed in this research effort were similar to those which proved successful in preceding transportation measurements [1], but were expanded to provide more complete coverage of the extreme low frequency (ELF) band (3 Hz to 3 kHz). An improved, free-body, electric field sensor was also added to obtain greater sensitivity and avoid perturbation of the electric field by the measuring device.

This effort demonstrated that complex (variable in time and space) ELF magnetic fields are present in every transportation system examined. The frequency and intensity characteristics of the magnetic field vary markedly between systems, at different places within each vehicle, and at different times at the same location, thus making it difficult to provide concise comparisons between transportation systems. But, if one averages the ELF magnetic field data across time, location within each vehicle, and multiple vehicles within a class, one finds the average field levels as indicated in Figure 1-1. To more fully comprehend the differences in magnetic field characteristics among transportation systems and to gauge the variability within each class of vehicles, one must examine the summary data for each transportation system reported in the body of this document. Figure 1-2 gives an expansion of Figure 1-1 showing how sub-bands of the ELF band contribute to the average field levels.

Time-varying electric fields are essentially non-existent in all of the transportation systems examined except the commuter rail system. On board that vehicle, 60 Hz electric fields from the 27.5 kV overhead catenary supply system averaged 2.3 V/m.

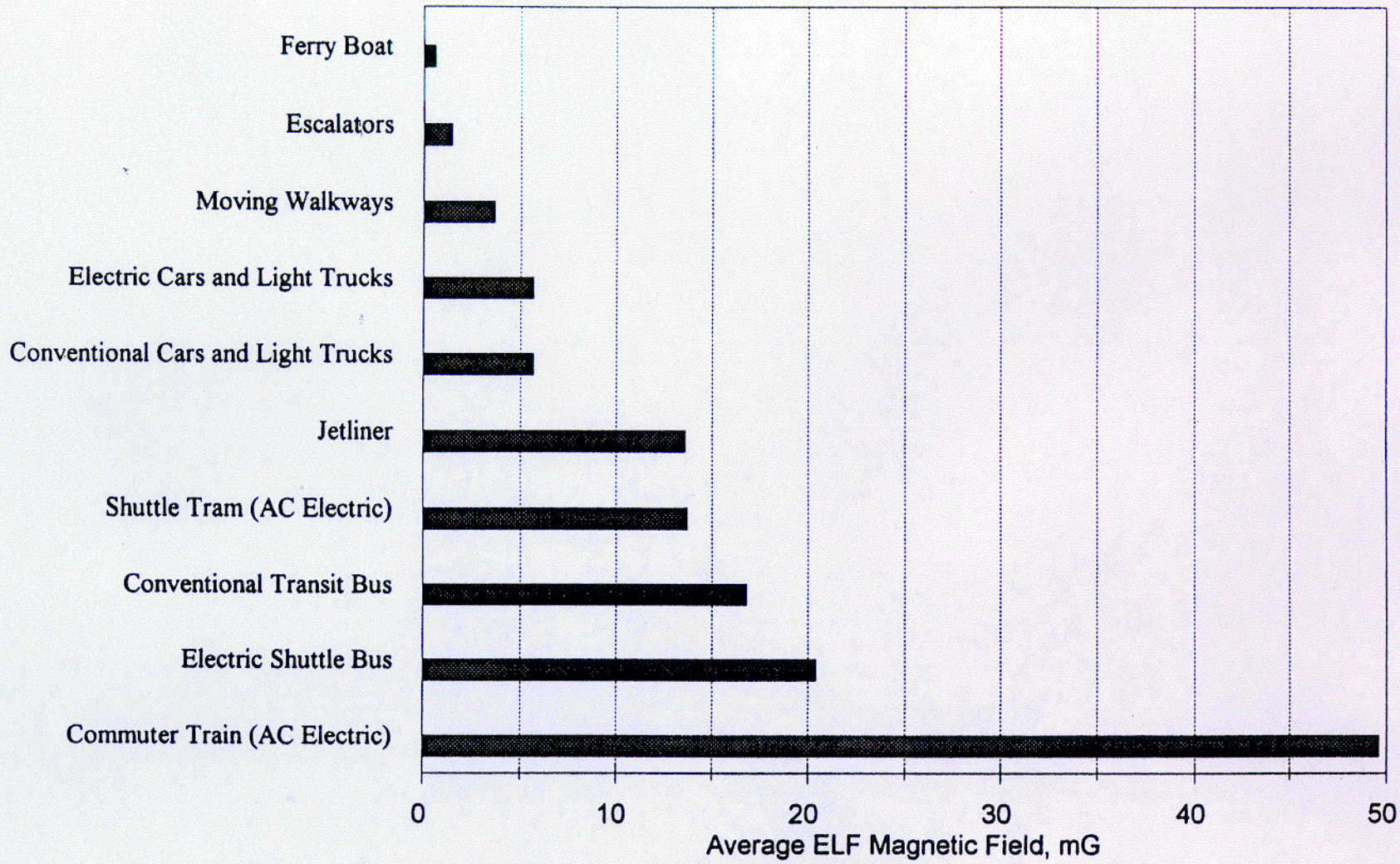

Figure 1-1 Average Extremely Low Frequency (ELF) Magnetic Field Levels Found in Ten Transportation Systems.

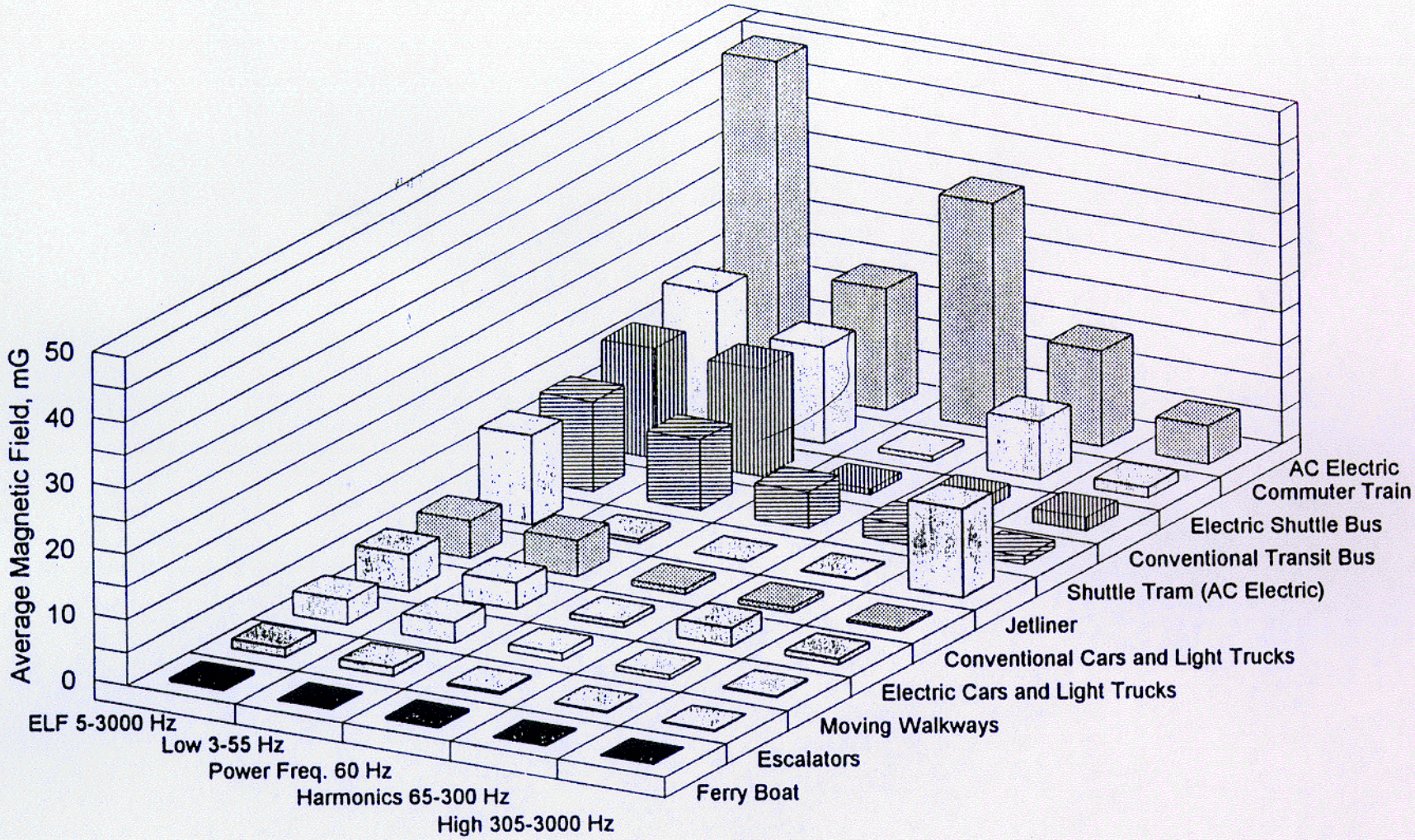

Figure 1-2 Average, Time-Varying Magnetic Field Levels in Ten Transportation Systems for Selected Frequency Bands.

ELF magnetic field levels in electrically powered vehicles using modern technology were not materially different than those in comparable systems using internal combustion power. Electric-powered personal highway vehicles (cars and light trucks) had average magnetic field levels similar to their internal combustion counterparts. Low frequency fields from similar sources are the dominant component in both types of vehicles. Magnetic field components at frequencies greater than 60 Hz are, on average, only a minor part of the total field environment in either conventional or electric cars and light trucks; however, higher frequency EMF levels are markedly higher in the electric vehicles.

The electric bus tested had similar low-frequency ELF fields to that of its diesel counterpart, but also had a significant (8.9 mG average) field in a higher frequency range which was well in excess of that in the diesel bus. As a result, the average ELF field in the electric bus was about 21% higher than that in the conventional bus.

The average ELF magnetic field levels in the self-powered ac-drive commuter rail vehicles was well in excess of that seen in smaller and lighter electric-powered vehicles. While the propulsion equipment under these cars contributed to the field levels within the vehicles, the total average field (49.6 mG) was well within the range of average magnetic field levels previously measured in coaches of conventional electrified railroads (19 to 134 mG) [1] where the traction power equipment was only in the locomotives.